would otherwise be possible for rapid withdrawal of the worm **2** when required.

It is noted that the entire hydraulic circuit shown in FIG. **1** is mounted in a single block right on the injection-molding machine. In fact, the spools of the two valves **14** and **35** may be rigidly interconnected and operated by a single solenoid in one direction with a single spring urging them in the opposite direction. Thus it is possible to make a very rigid and leak-proof assembly for controlling the operation of the worm **2.**

FIGS. **2** and **3** illustrate the operation of the above-described hydraulic control system. The various pressures are illustrated schematically by the types of lines in the various conduits. A simple dashed line (-----) indicates the minimum pressure at the inlet side of the pump or at the reservoir of the system, a dash triple-dot (-...-...-) line is the pressure in the cylinder during filling of the molding machine, a dash double-dot (-..-..-) line indicates the control pressure for the valve **9,** and a dot-dash (-.-.-) line is the highest pressure in the system corresponding to the high-pressure side of the pump, the holding pressure, or the injecting pressure. The control pressure is greater than the back pressure and the holding or injecting pressure is higher than the control pressure.

As shown in FIG. **2,** during injection and holding the chamber behind the piston of the cut-off valve **13** is connected to the return line so that this valve **13** will be fully opened. Thus it is possible for pressure to flow from the line **11** through the control valve **9,** the throttle valve **12** and the open cut-off valve **13** to the chamber **5.** The pressure will be determined by the pressure-reducing valve **9** which has a housing **9***a* subdivided by a piston **9***b* into a pair of chambers. An orifice **9***c* through the piston allows limited fluid flow between the chambers and a spring **9***d* urges the piston **9***b* in a direction tending to increase fluid flow between the inlet and outlet side.

Thus it should be apparent that if the pilot port of the valve **9** is blocked off pressure will bleed through the orifice **9***c* and equalize pressure on both sides of the piston **9***b*, allowing the spring **9***d* to push the piston **9***b* to the right in FIG. **2,** therefore opening the valve **9** up altogether and allowing maximum pressure to flow through this valve **9.** The pilot port of the valve **9** is, however, supplied with fluid under pressure by displacement of the valve **35** through the controller **40'** such that the port **38** connected to the pilot port of the valve **9** is connected to the inlet side of the pressure-control control valve **34.** The programmer **40'** is, as described above, also connected to this pressure-control valve **34** and serves to maintain a pressure at the pilot port of the valve **9** which ensures the proper injecting pressure during injection, and automatically changes this pressure at the pilot port to the appropriate pilot pressure for obtaining the requisite holding pressure in the chamber **5.**

During injection and holding the pilot pressure shown by the dash double-dot line in FIG. **2** cannot be effective through the check valve **36** on the pressure-relief valve **26.** Since this pressure-relief valve **26** has a small-diameter restricted passage **26***a* in its piston **26***b* the pressure will after a brief interval be equal on both sides of the piston **26***b* so that the spring **26***c* of this valve **26** will close it completely. Thus the pressure-control valve **34** which controls the pilot pressure for the pressure-reducing valve **9** and pressure relief valve **26** sets the levels of the holding pressure and the injecting pressure as well as back pressure.

During the clamping operation it is possible to operate the worm **2** with increased speed by actuation of the four-way valve **21** so as to open the cut-off valve **20** and bypass the throttle **12.**

As shown in FIG. **3** during the filling of the injection-molding machine, as the screw rotates and is pushed backwardly by the plastified synthetic-resin material, the valves **14** and **35** are in the position indicated in FIG. **3.** In this position the valve **14** connects the shut-off valve **13** to the high-pressure line **11** so as to close this valve **13** and absolutely prevent fluid flow through the series-connected valves **9, 12** and **13.** Even opening of the valve **20** in this position will be completely ineffective to feed fluid under pressure to the chamber **5.**

The valve **35** is effective during the filling of the injection-molding machine to connect the pilot port of the pressure-relief valve **26** to the pressure-control valve **34.** The programmer **40'** is effective to set the pilot pressure for the relief valve **26** so that a relatively low pressure is maintained in the chamber **5** and the worm **2** can back up. Opening of the pressure-relief valve **26** allows excess pressure in the chamber **5** to drain off into the reservoir **27,** although instead of reservoir **27** the output side of this valve **26** could be connected to the return line **17,** the return line **17** and the reservoir **27** constituting effectively the low-pressure side of the pressure source whose high-pressure side is the line **11.** During this part of the operating cycle, the pilot pressure effective against the back side of the check valve **36** grows to be substantially equal to the pressure in the line **11.** The valve **36,** however, prevents this pressure from being effective at the pilot port of the pressure-relief valve **26.**

During filling it is possible to operate the valve **29** so as to open the cut-off valve **28** to bypass the pressure-relief valve **26** and allow extremely rapid backing of the piston **4.**

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of systems differing from the types described above.

While the invention has been illustrated and described as embodied in a control system for an injection-molding machine, it is not intended to be limited the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

We claim:

1. In combination with an injection-molding machine having a drive ram with a pressurizable chamber and with a source of fluid under pressure having a high-pressure side and a low-pressure side, a control system comprising: a pressure-reducing valve having an inlet port connected to the said high-pressure side, an outlet port connected to said chamber, and a pilot port, means operable in said pressure-reducing valve whereby the pressure at said pilot port determines the pressure at said outlet port; a pressure-relief valve having an inlet port connected to said chamber, an outlet